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CONTROLLING THE CLOVER-FLOWER MIDGE IN THE PACIFIC NORTHWEST

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TINY MAGGOTS in red-clover flowers prevent the seeds from maturing and cause a great reduction in the seed crop. These maggots are the young of a very minute fly known as the clover-flower midge.

The farm practices by which this little pest can be controlled in the Pacific Northwest are, with certain modifications, the same as those followed in the East, namely, close pasturing, early cutting, clipping, and soiling. These measures are explained on pages 10 to 12.

Close pasturing of red clover until late May or early June is an effective means of exterminating the midge. If close pasturing is impracticable, run a mower over the field to clip off the stray heads before starting the seed crop.

Where both hay and seed crops are desired, cut the hay crop by June 1. This will control the midge effectually and prevent infestation. Never put off the cutting beyond the first week in June unless the weather is unfavorable, in which case the crop should be cut just as soon as fair weather returns.

Clipping and soiling red clover during the spring and early summer are equally efficacious methods of exterminating the midge, provided young heads of the seed crop are not allowed to appear before the middle of June.

CONTROLLING THE CLOVER-FLOWER MIDGE IN THE PACIFIC NORTHWEST.

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ESTABLISHMENT AND DISTRIBUTION IN THE PACIFIC NORTHWEST.

THE CLOVER-FLOWER MIDGE[1] (fig. 1), long recognized by the clover-seed growers of the Eastern and Central States as one of their most serious pests, has become established in the Pacific Northwest, and since 1913 has caused alarming reduction in the seed yields. While the insect undoubtedly became established on the Pacific coast a number of years prior to 1913, there is no record of its having been present in sufficient numbers to affect the clover-seed industry seriously.

FIG. 1.—The clover-flower midge. Enlarged side view of female fly with scales denuded to show more clearly the structure. Greatly enlarged.

The midge now occurs throughout Washington and Oregon west of the Cascades wherever red clover is grown, and east of the Cascades in the Yakima and Columbia Valleys of Washington and the Jocko Valley of western Montana. It has not yet been reported from the great seed section of Idaho, or from the coast counties of northern California where red clover is raised to a limited extent.

This insect is readily controlled in the East by following certain farm practices, and investigations by the Department of Agriculture have shown that, with certain modifications, these practices can be followed successfully in the Pacific Northwest

[1] *Dasyneura leguminicola* (Lintner); order Diptera family Cecidomyiidae.

FOOD PLANTS AND NATURE OF INJURY.

Red clover is the chief food plant of the clover-flower midge in Oregon and Washington, as is the case in the States east of the Rocky Mountains. The midge is rarely found on either white or alsike clover and is never present on these plants in sufficient numbers to affect seed production.

The clover-flower midge is injurious only in its larva or maggot stage. As its name implies, it works in the flower (fig. 2), feeding upon those parts which normally would develop into seed. Although one maggot prevents the formation of only a single seed, the insects can make serious inroads on the seed crop when present in great numbers, as they usually are in infested fields.

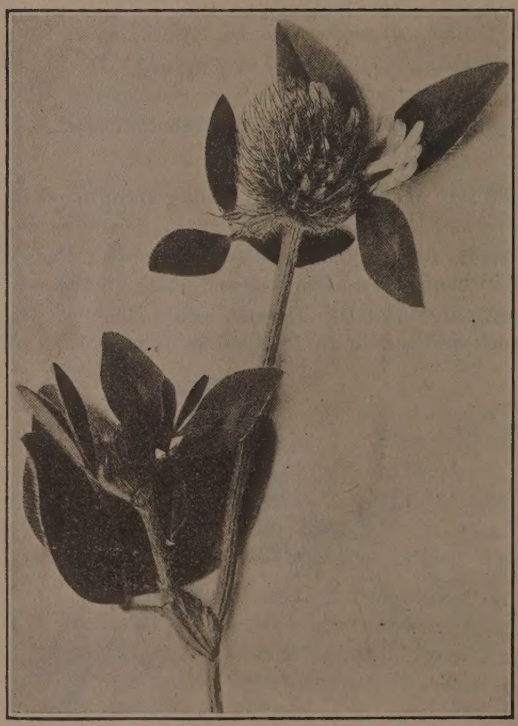


FIG. 2.—Clover heads injured by the clover-flower midge.

The forage value of red clover is not impaired by midge infestation and the insect, therefore, is of economic importance only in seed-growing districts.

SEASONAL HISTORY.

The clover-flower midge, which is a delicate mosquito-like fly, passes the winter as a larva, or maggot, generally in a silken case or cocoon on or slightly below the surface of the ground. Occasionally no cocoons are spun, especially where ample protection is afforded by the débris covering the surface of the soil. The coccoon is very small, oval, and measures approximately one-tenth of an inch in length and one-twentieth of an inch in diameter. It is constructed of a white papery substance of a leathery consistency and is very difficult to recognize in its natural location because of the coating of earth which usually obscures completely the cocoon proper, causing it to resemble a small lump of earth.

With the first warm days of early April a few of the larvæ in the cocoons begin to change to the pupa or resting stage, and by the

first of May the greater portion of the brood has either begun to transform or is in the pupa stage. The pupa period during April and May lasts from two to three weeks, depending upon the season. In seasons of an early spring a few midges complete their transformation and emerge as adults by April 21. If the season is late none may be found in the fields before May 5.

The adult fly (fig. 2) is somewhat smaller than a mosquito and of similar delicate and fragile structure. It is strikingly and beautifully marked, the anterior half being black, with hair-fringed dusky wings, and the posterior half, or abdomen, bright vermilion red in fresh specimens. The abdomen of the female is equipped with a long extensible egg-laying tube, or ovipositor, by means of which the eggs are inserted in the young clover heads. The male differs from the female in being more slender and fragile, and the shorter abdomen is equipped with a pair of clasping organs used in mating.

Unless the season is unusually late, by May 5 young clover heads have begun to appear in noticeable numbers and adults are common. The maximum abundance usually is reached between the 18th and the 25th of the month. From this time on there is a gradual decrease in numbers until about the latter part of the first week in June, by which time they have become relatively scarce. Scattered individuals often are found, however, until the latter part of June.

While the foregoing briefly outlines the periods when adult midges may be expected to be on the increase or decrease in a given clover field, it must not be supposed that this increase or decrease is at all uniform. The cool rains of several days' duration which occur at frequent intervals during the month of May cause a temporary sharp decrease in numbers by checking the emergence of new adults, and a corresponding increase in numbers may always be looked for during the fair weather immediately following such rains.

Upon emerging, the females, which are much more plentiful than the males, mate and proceed to the small green clover heads, and in these they lay their eggs. In selecting a place for egg-laying marked preference is shown for young clover heads which are just beginning to appear through the leaf sheath, but the midge if at all numerous frequently will select older heads providing they are still green.

The egg is oval, about three times as long as broad, and barely visible to the naked eye. It is pale yellow at first, but an internal orange spot appears just before hatching. Eggs are found both singly and in clusters, usually stuck to the hairs of the calyx (fig. 4) or to the calyx itself, but not infrequently in clusters just inside the leaf sheath, or on young leaves surrounding the head. When found attached to calyx hairs the eggs occur either singly or in very small clusters. When found between the leaf sheath and the head the

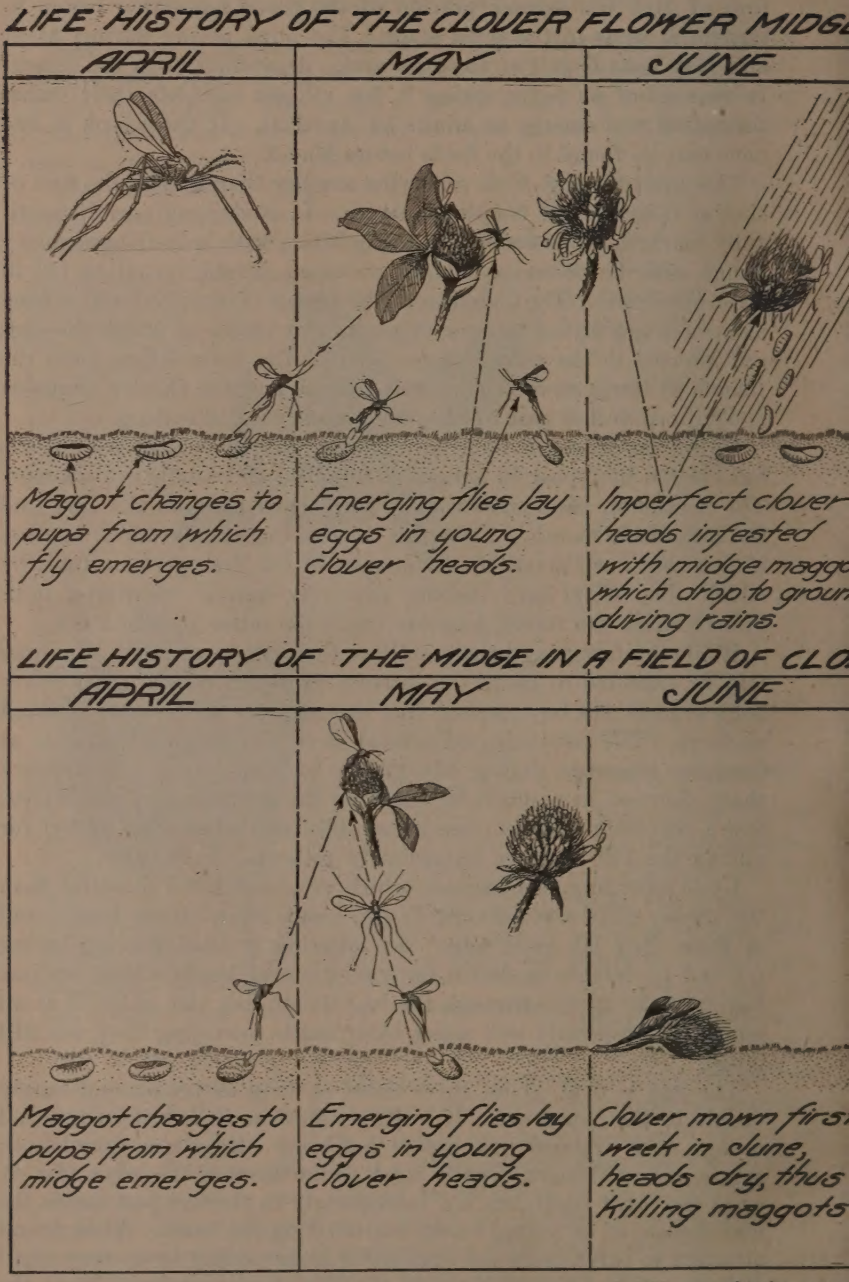
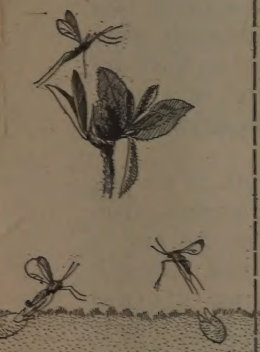
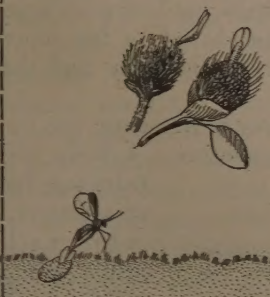
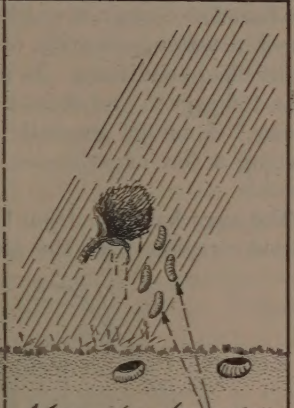
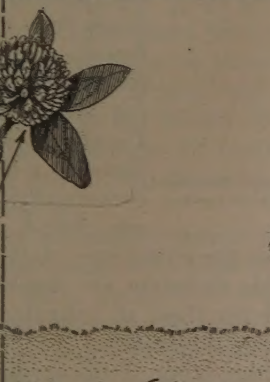

LIFE HISTORY OF THE CLOVER FLOWER MIDGE
APRIL
MAY
JUNE
Maggot changes to pupa from which fly emerges.
Emerging flies lay eggs in young clover heads.
Imperfect clover heads infested with midge maggots which drop to ground during rains.
LIFE HISTORY OF THE MIDGE IN A FIELD OF CLOVER
APRIL
MAY
JUNE
Maggot changes to pupa from which midge emerges.
Emerging flies lay eggs in young clover heads.
Clover mown first week in June, heads dry, thus killing maggots

FIG. 3.—Diagram showing season

A FIELD OF CLOVER CUT IN LATE JUNE

JULY	AUGUST	SEPTEMBER
		
ummer generation f midge emerges to ay eggs on heads f new crop.	Heads of clover badly infested, seed crop lost.	Maggots dropping to ground during fall rains in order to enter soil for the winter.

R CUT IN EARLY JUNE AS RECOMMENDED

JULY	AUGUST	SEPTEMBER
		
lover heads free from infestation y midge develop rmally.	Heads full of florets, insuring perfect setting of seed.	Ripening clover head free from maggots and bearing seed.

tory of the clover-flower midge.

clusters are usually larger and contain from 10 to 20 eggs. In the laboratory a single midge has been observed to lay as many as 86 eggs, but as the majority of females when they emerge from cocoons are found to contain over 100 eggs, it is probable that the latter number is a better indication of what the average female actually lays under field conditions. It is not unusual to find considerably more than 100 eggs in and about a single head, or more eggs than there are florets. A midge generally spends only a few minutes on a head, placing a few eggs in one or two locations and then flying on to another.

The eggs hatch in from three to five days, the length of the egg period varying with the temperature. A larva, or maggot, upon hatching from the egg is of a watery, pale yellowish color, with an internal bright orange spot plainly visible to the naked eye. The young legless maggot wriggles to the top of the floret and forces its way inside through the unopened petals. Upon obtaining entrance, it works its way down to the young ovary; here it feeds by sucking the juices from this part of the flower, thereby destroying the ovules and thus preventing the formation of seed. Usually only one maggot is found in a single floret, but occasionally two or more are found. A floret infested with a midge larva shows the injury very plainly, as the petals rarely expand. Infested heads therefore are distinguished easily, their imperfect blossoming giving them an irregular or mangy appearance. (Fig. 2 and title-page illustration.)

FIG. 4.—Eggs of the clover-flower midge fastened to hairs of calyx in immature red-clover flowers. Highly magnified.

The time required for a midge larva of the spring generation to complete its growth is approximately four weeks. Few of them complete their development before the last of May, and mature larvæ are not found in the clover heads in noticeable numbers before the end of the first week in June. If the season is exceptionally late it may be impossible to find full-grown maggots before the second or third week of the month. The maggots not only grow rapidly but undergo a pronounced change in color while feeding in the florets. They

change gradually from a watery yellow to creamy white as they increase in size, and shortly before reaching maturity become a salmon pink, remaining this color until becoming full grown. Upon reaching maturity the maggots measure approximately one-tenth of an inch in length and entirely fill the florets, taking the place of the seed.

The mature larvæ do not drop at once to the earth to pupate but await sufficient rain thoroughly to moisten the clover heads and the surface of the ground. In Oregon and Washington it is not uncommon for two or three weeks to elapse between the date of maturity of a considerable percentage of the midge brood and the occurrence of a sufficient amount of rainfall to bring them out of the heads. After dropping out of the clover heads in June the maggots work their way a short distance into the ground, generally through small cracks in the soil, and lose no time in spinning cocoons similar to those in which the parent generation passed the winter. Unless it becomes exceptionally dry immediately following the spinning of cocoons, the maggots of the summer generation do not remain dormant in the cocoons but pupate at once. The pupa period at this season of the year is generally from two to three weeks, but a spell of dry weather will often lengthen it, and a prolonged drought such as occurred during the summers of 1914 and 1917 results in the death of many of the larvæ and pupæ.

The first adults of the summer generation may be expected to appear in the fields any time between July 1 and 15. If there is a fair amount of rainfall during July they emerge in constantly increasing numbers until about July 22. After this date there is a rather rapid decrease in numbers until about the middle of August, when very few are to be found. On the other hand, if there is no rainfall during July this generation will be relatively scarce, reach its height, and completely disappear by the middle of that month. The adults of this generation lay their eggs in the young heads of the seed crop, where they hatch and undergo the same development as described for the spring generation.

The maggots of the summer generation also require approximately four weeks to reach maturity. Most of them complete their growth in early August, but if the summer is dry they frequently remain in the heads until the clover is hulled, or, if the crop is left standing, until the fall rains occur. If sufficient rain falls during the late summer, however, they drop to the ground, pupate, and emerge as adults during late August, September, and, occasionally, well into October. The adults of this third generation lay their eggs in the late heads in the fields from which they emerge, and probably also in the young heads of the spring-sown clover, which frequently appear at this season of the year. The greater part of their progeny have ample time to complete their growth before killing frosts occur. In any

case, sufficient progeny of either the second or third generation of midges survive the winter to emerge as adults and propagate during the following spring.

CONTROL MEASURES.

PASTURING.

The practice of pasturing red clover previous to starting a seed crop has proved to be as effective a means of midge control in Oregon and Washington as it was shown to be in Ontario, Canada, and in our eastern States. In favorable seasons clover often makes sufficient growth the first year to enable the farmer to begin pasturing in the early fall. Fall pasturing is valuable in that it keeps down the volunteer heads in which the midge would otherwise secure a foothold in the field the first season. In any event, the clover always makes sufficient growth to permit pasturing the following spring. Pasturing the field during April and May exterminates the midge, either directly by the destruction of the clover heads containing the eggs and partially grown larvæ, or indirectly by preventing the heads from forming during the time the adults of the spring generation are laying their eggs. The live stock may be removed from the field the latter part of May or left until early June, depending upon the season. In case the pasturing has not been close enough to get all of the heads, a mower should be run over the field shortly after the stock is removed in order to cut what remains. This practice not only results in the destruction of the immature midge larvæ which may happen to be present in these heads but also keeps down the weeds that otherwise might be present in the seed crop.

EARLY CUTTING.

As the majority of farmers raising red clover desire to secure both hay and seed crops, the practice of early cutting of the hay crop has to be resorted to in midge-infested districts. This method of midge control has for its object the destruction of the first brood of midge maggots by the cutting off and drying up of their food supply. Early cutting can be practiced successfully by the clover-seed growers of Oregon and Washington, but on account of the seasonal variations and general climatic conditions existing in the Pacific Northwest it is more difficult to lay down a general rule, stating approximately upon what date to cut each year, than it is in the Eastern States, where conditions are more nearly uniform. To practice early cutting effectively the farmer must not only keep himself informed as to the development of the clover itself (fig. 5) but also as to the development of the midge larvæ within the heads. The changing of tint of the larvæ in the majority of the infested heads in the field from a creamy white to a salmon pink indicates that they are rapidly approaching maturity and that cutting should not be delayed long if the majority of the larvæ are to be killed by this means.

Life-history studies made throughout four seasons of varying climatic conditions indicate that few of the maggots of the spring generation ever reach maturity before the end of the first week in June. Therefore it can be safely stated that if the clover is cut by June 1 the cutting will destroy the maggots of the spring generation regardless of the season and will assure an uninfested seed crop, except for such slight infestation as comes from the few scattered individuals that possibly may invade the field from the roadsides or that may be blown over by the wind from a neighboring field. (See fig. 6.)

FIG. 5.—Young clover head showing stage when clover-flower midge lays its eggs.

Further investigations and experiments, however, have shown that in most seasons the clover can be cut at a slightly later date than June 1 with safety, thus enabling the farmer who is willing to assume the risk of unfavorable weather to obtain a greater amount of forage from his field than would be possible otherwise. The reason that this later cutting is usually effective lies entirely in the fact that midge larvæ, after they complete their development, do not leave the clover heads and drop to the ground to pupate until there has been sufficient rainfall to moisten the florets thoroughly. If, therefore, the hay crop is cut and removed from the field any time between the first week in June and the date of the first rainfall thereafter which exceeds approximately one-tenth inch, the result will be fully as effective as it would have been had the crop been cut while the maggots were still immature. As the date of this rainfall is uncertain, however, varying between the 7th and the 21st of the month, it is unwise to postpone cutting of the hay crop any later than necessary after June 1.

A good rule to follow is to cut the hay crop during the first week in June providing the weather is favorable. If it is rainy during that week, wait and cut the crop as soon as the sky clears and the weather becomes settled.

CLIPPING.

Some farmers, who desire neither to pasture nor to secure a hay crop, follow the practice of cutting their clover back between the 10th and the 25th of May, leaving the clippings on the ground as a mulch. In fields clipped May 15 or earlier, however, the seed crop is apt to be somewhat infested with the midge, owing to the fact that the clover makes sufficient growth to produce young heads in early June before the adult midges of the spring generation have entirely disappeared. The safest rule to follow is to clip not earlier than May 20. Clover cut about this date will not produce young heads until after the adults of the spring generation are gone, and

FIG. 6.—Field of clover from which the hay crop was cut June 1, the perfect blossoms showing the absence of the clover-flower midge.

these heads will be far enough advanced by the 1st of July to be immune from attack by any of the adults of the summer generation which begin to appear in the fields soon after that time.

SOILING.

A few farmers who combine clover-seed production with dairying find it desirable to cut their clover and feed it green during the spring and early summer. This practice, known as soiling, affords an effective means of controlling the midge, providing the same precaution is taken as in clipping; i. e., that the clover be held back sufficiently to prevent young heads of the seed crop from developing before the middle of June. In cases where the clover has been cut in late April or early May it may be necessary to cut it a second time about June 1 in order to accomplish the above result.

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